



Comparative Evaluation of Natural Tooth Whitening Agents: Strawberry Puree and Activated Charcoal – An In-Vitro Study

YUGHANILA.V(CRI) VIJAYALAKSHMI RAJAN.K(CRI), VIGNESH KIRTHIK.C.R(CRI), VENKATRAMAN.S(CRI), DR.KALAIVANI(MDS) DEPARTMENT OF PUBLIC HEALTH DENTISTRY ADHIPARASAKTHI DENTAL COLLEGE AND HOSPITAL.

Abstract

Introduction: Tooth discoloration is a common aesthetic concern that affects an individual's confidence and appearance. Although chemical bleaching agents are widely used for whitening, they may cause adverse effects such as tooth sensitivity and enamel damage. Therefore, natural whitening agents are gaining attention as safer alternatives.

Aim: To evaluate and compare the tooth-whitening efficacy of two natural agents—strawberry puree and activated charcoal—on artificially stained enamel samples.

Materials and Methods: Extracted human teeth were cleaned and artificially stained using a coffee solution for three days. The specimens were divided into two groups based on the whitening agent used: strawberry puree and activated charcoal. Each sample was coated with the respective material and allowed to remain in contact with the enamel surface for three hours under controlled laboratory conditions. Color measurements were obtained using a digital spectrophotometer before and after treatment. The whitening effect was evaluated using color change values.

Results: Both natural agents demonstrated a measurable whitening effect on stained enamel surfaces. However, activated charcoal showed a greater degree of whitening compared to strawberry puree over the experimental period.

Conclusion: Within the limitations of this in-vitro study, activated charcoal exhibited a higher whitening potential compared with strawberry puree. Natural agents may serve as safer alternatives to conventional chemical bleaching methods, though further clinical studies are required.

Keywords: Tooth whitening, natural bleaching agents, activated charcoal, strawberry extract, enamel discoloration.

Introduction

In modern society, aesthetic appearance plays an important role in personal confidence and social interaction. A bright smile is often associated with attractiveness and good oral health. Teeth significantly influence facial aesthetics because they are prominently visible during speech and smiling. Tooth discoloration can therefore negatively impact self-esteem and social perception. [OB]

Dental discoloration may occur due to extrinsic factors such as consumption of coffee, tea, wine, and tobacco products, as well as intrinsic causes such as aging or medication use. Among these, dietary stains are one of the most common causes of enamel discoloration.

Conventional tooth-whitening techniques often involve chemical bleaching agents such as hydrogen peroxide or carbamide peroxide. Although these agents are effective, they may cause undesirable effects including enamel surface alteration, tooth sensitivity, and irritation of oral tissues. As a result, there has been increasing interest in natural and non-invasive alternatives for tooth whitening.

Natural products such as strawberries and activated charcoal have gained popularity as home remedies for whitening teeth. Strawberries contain malic acid, which acts as a natural exfoliating agent capable of removing superficial stains from the enamel surface. Activated charcoal, on the other hand, has strong adsorptive properties, enabling it to bind pigments and remove discoloration from the tooth surface.

Despite their popularity, scientific evidence supporting the whitening efficacy of these natural agents remains limited. Therefore, the present in-vitro study was conducted to evaluate and compare the whitening effect of strawberry puree and activated charcoal on artificially stained teeth.

Materials and Methods

Study Design

This study was designed as an in-vitro experimental study to evaluate the whitening efficacy of two natural tooth-whitening agents.

Sample Preparation

Extracted human teeth without caries, cracks, or structural defects were selected for the study. The teeth were cleaned thoroughly to remove debris and stored in distilled water until use.

Artificial Staining Procedure

To simulate tooth discoloration, the specimens were subjected to artificial staining using a coffee solution. The staining solution was prepared by dissolving 20 g of instant coffee in 100 mL of boiling water. Each tooth specimen was immersed in the coffee solution for three consecutive days, and the solution was replaced every 24 hours to ensure uniform staining. [OBJ]

After staining, the specimens were rinsed with running water for 30 seconds and air-dried.

Preparation of Whitening Agents

Strawberry Puree

Fresh strawberries (100 g) were washed thoroughly, cut into small pieces, and blended to obtain a smooth puree. The puree was stored in a sealed container at 4°C until use.

Activated Charcoal

Commercially available activated charcoal powder was used for the study. The powder was mixed with a small quantity of distilled water to form a paste suitable for application.

Application of Whitening Agents

The stained teeth were divided into two groups:

Group 1: Strawberry puree

Group 2: Activated charcoal

Each specimen was coated uniformly with its respective whitening agent. The material remained in contact with the enamel surface for three hours under controlled laboratory conditions. After treatment, the specimens were rinsed thoroughly with distilled water to remove residual material.

The samples were then stored in sealed containers containing distilled water at room temperature for 24 hours prior to color evaluation. [OBJ]

Color Measurement

Color measurements were performed using a digital spectrophotometer. Baseline readings were recorded prior to treatment, and final readings were taken after the whitening procedure.

The color change was calculated using the ΔE formula:

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

This value represents the degree of color change between pre- and post-treatment measurements.

Results

The whitening effects of the two natural agents were evaluated over a three-day period using digital color measurements.

Day 1 Observations

Initial application of both agents produced a mild whitening effect. Strawberry puree produced slight stain reduction due to its acidic action, while activated charcoal showed moderate removal of surface pigments.

Day 2 Observations

On the second day, the whitening effect became more noticeable. Activated charcoal demonstrated greater improvement in tooth brightness compared to strawberry puree, indicating stronger pigment adsorption.

Day 3 Observations

By the third day, activated charcoal produced the most pronounced whitening effect, with the enamel surface appearing significantly lighter compared to the strawberry group. Strawberry puree showed moderate improvement but remained less effective than charcoal.

Overall, the results indicated that activated charcoal produced a greater degree of color change than strawberry puree.

Day	Group	Hex value	RGB	HSV	Interpretation
Day1	Activated charcoal	#6E6767	RGB(110,103,103)	HSV(0°,6%,43%)	Moderate discoloration
Day1	Strawberry	#3E1309	RGB(62,19,9)	HSV(11°,85%,24%)	Dark stain present
Day2	Activated charcoal	#EEFDFD	RGB(238,253,255)	HSV(187°,6%,100%)	Significant whitening
Day2	Strawberry	#908B8C	RGB(144,139,140)	HSV(348°,3%,56%)	Mild whitening
Day3	Activated charcoal	#FFFFFF	RGB(255,255,255)	HSV(0°,0%,100%)	Maximum whitening
Day3	Strawberry	#70736F	RGB(124,115,111)	HSV(18°,10%,48%)	Moderate whitening

Discussion

Tooth whitening has become one of the most popular cosmetic dental procedures. Increasing awareness of potential side effects associated with chemical bleaching agents has led to a growing interest in natural whitening alternatives.

Strawberries contain malic acid, which acts as a mild natural acid capable of dissolving superficial stains on enamel. This explains the moderate whitening effect observed in the strawberry group. However, excessive acidic exposure may potentially weaken enamel if used frequently.

Activated charcoal possesses a highly porous structure and strong adsorption capacity. These properties allow charcoal particles to bind stain molecules and remove them from the enamel surface. This mechanism explains the greater whitening effect observed in the charcoal group compared to strawberry puree.

The findings of the present study are consistent with previous studies evaluating natural whitening agents, which reported that activated charcoal demonstrated superior stain removal due to its adsorptive characteristics.

However, the study has certain limitations. Being an in-vitro experiment, it does not completely replicate oral conditions such as saliva, mastication, and oral microbiota. In addition, long-term effects of these agents on enamel integrity were not evaluated.

Further clinical studies are required to confirm the safety and effectiveness of natural tooth-whitening agents under real oral conditions.

Conclusion

Within the limitations of this in-vitro study:

- Both strawberry puree and activated charcoal demonstrated the ability to reduce extrinsic tooth stains.
- Activated charcoal showed a greater whitening effect compared to strawberry puree.
- Natural whitening agents may serve as affordable and accessible alternatives for mild stain removal.

However, further clinical research is necessary to evaluate their long-term safety and effectiveness.

References

1. Senthilkumar V, Ramesh S. Comparative evaluation of natural tooth whitening agents – An in vitro study. *International Journal of Dentistry and Oral Science*.
2. Kwon SR, Wertz PW. Review of the mechanism of tooth whitening.
3. Joiner A. The bleaching of teeth: A review of the literature.
4. Abouassi T, Wolkewitz M, Hahn P. Effect of carbamide peroxide and hydrogen peroxide on enamel surface.
5. Raut AW, Mantri V, Gedam PV. Conservative esthetic management of dental discoloration.